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Geoconservation and tourism at geothermal sites – lessons learnt from the Taupo Volcanic Zone, New Zealand

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ABSTRACT

Geothermal sites are specific and fragile components of geoheritage, of considerable value to tourism, which require special conservation measures if their activity is to be sustained. In this paper opportunities, threats and challenges associated with geoconservation and geotourism at such sites are discussed using examples from the North Island of New Zealand, which is the cradle of modern geothermal tourism on the global scale, dating back to the mid-19th century. Five locations with geothermal phenomena, situated between Rotorua and Taupo, are subject to detailed analysis: Te Puia Whakarewarewa, Waimangu, Wai-O-Tapu, Orakei Korako and Craters of the Moon. Geothermal sites from Taupo to Rotorua area provide examples of good practice in the development for tourism in terms of physical facilities, with safety and control measures not being too intrusive and not interfering with the scenic qualities of the sites. Direct threats from tourism industry are rather minor and kept to minimum. Negative influences of groundwater pumping and energy production pose more hazard to the future of geothermal fields, although Rotorua is also an example of successful recovery of geothermal features after limitations on overexploitation of hydrothermal resources were enforced in the 1980s.

1. Introduction

Locations with active geothermal phenomena are specific examples of geoheritage which require special site management practices. This is because they combine contemporary dynamics of the Earth with inherited elements which may be a few tens to a few thousand years old, often in a setting whose geological history can be traced much further back in time. In such context, effective conservation cannot be guided by the principle of protection against any change since the nature itself is constantly changing the locality and may even alter it completely in a very short time.

The issue of geological conservation at geothermal sites becomes of special importance in places developed for tourism purposes (Erfurt-Cooper, 2011; Newhall, 2014). These localities, often abounding in geysers, boiling springs and pools, fumaroles (steam vents), mud pools and mud volcanoes, devoid of vegetation and looking 'otherworldly', have long been of interest to casual tourists and geotourists alike. Early evidence of such interest comes from the antiquity when people in the ancient Roman Empire travelled to see the solfatara field at Campi Flegrei near the contemporary Naples in south Italy (Armiero et al., 2011). There is also a long tradition of using hot springs for curative purposes (Erfurt-Cooper and Cooper, 2009) and many famous health and spa resorts in Europe have been developed since the Roman times too, although they are not necessarily associated with other visual manifestations of geothermal activity. Reasons of attractiveness of geothermal sites are multiple, arising from the general intention to experience something unusual in terms of visual appearance, spectacularly dynamic (geyser eruptions, steam emissions), often very colourful, and involving all senses, including hearing and smelling. All this can also appeal to more conscious geotourists who become additionally attracted by the perspective to get insights into how the Earth works, to enjoy diversity, and to deepen understanding of crucial processes for the evolution of the planet. In addition, other branches of tourism use geothermal resources to develop their products, with or without conjunction with nature-based tourism. These include leisure tourism at hot pools, more sophisticated spa and wellness tourism, as well as cultural tourism which capitalizes on indigenous use of hot waters and associated traditions.

Geothermal sites can be visited in various places of the world, with some localities being more famous than others, and also

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better developed and prepared to handle increasing tourist flows. Leaving the Italian example aside, the North Island of New Zealand is probably the oldest tourist destination in the world which owed its fame to geothermal phenomena and their observable effects. Tourist visits to specifically see hot springs and colourful sinter terraces date back to the mid-19th century (McClure, 2004; White and Chambeford, 2016) and geothermal tourism was soon followed by spa tourism, based on abundant geothermal resources in Rotorua (Climo et al., 2016). Further examples come from the United States, particularly from the Yellowstone National Park, whose geysers and hot pools were a major tourist attraction since the establishment of national park in 1872 (Magoc, 1999; Grusin, 2004). Another locality is Lassen Volcanic National Park in northern California, where several active geothermal fields occur, e.g. Bumpass Hell, postdating catastrophic eruption of the volcano in 1915 (Clynne et al., 2003). In Europe, Iceland is an obvious destination for volcano tourism (Dowling, 2010), with numerous geothermal sites scattered across the country, along the divergent plate boundary that crosses the island from SW to NE. Although the archetypal Geysir is currently inactive, Strokkur geyser at the same site reliably erupts with the frequency of around 10 min, attracting masses of tourists. Less known but perhaps more diverse are geothermal phenomena in the Reykjanes Peninsula (Krýsuvík, Gunnuhver), recently (2015) granted the status of a European Geopark. Likewise, geothermal phenomena in the Azores archipelago are emphasized within the Azores Geopark (Nunes, 2014). Another country known for its geothermal phenomena is Japan, with such famous localities as Beppu and Aso (Erfurt-Cooper, 2010).

Observing growing popularity of geothermal sites a major issue emerges at the interface of geoheritage, geoconservation, and tourism, particularly geotourism (Erfurt-Cooper, 2011). The central problem is how to reconcile site development for geotourism to meet demands from the tourism industry and the visitors, with effective management of geothermal heritage. In this paper, our aim is to review existing and potential opportunities, threats and challenges, using specific examples from New Zealand – the cradle of modern geothermal tourism. In this way we provide lessons to learn and suggest solutions to adopt at other geothermal sites, where growth of visitations is observed or anticipated.

2. Geoconservation at geothermal sites – opportunities, threats and challenges

Implementation of geoconservation is not without conflicts with interests other than safeguarding geoheritage (Erikstad, 2013; Gray, 2013). Each type of geoheritage has its own peculiarities which create special opportunities to raise public awareness of its value, but generate specific threats and challenges as well. Geothermal sites are no different.

Geotourism is considered as an effective means to both increase appreciation of geoheritage and convince local stakeholders that economic benefits may arise from sustainable use of geo-resources. In this context, the role of geotourism at geothermal sites becomes particularly important since they are among most appealing and easy to see geological phenomena, hence with high potential to generate interest in Earth science. Geothermal phenomena are particularly suitable to show links between geological past and the present, since the stage for current activity of geysers, hot springs and mud volcanoes was set in the distant past, in relation to the history of plate boundaries or hot spots. Moreover, in contrast to many other types of geoheritage perceived as of purely academic interest, it is relatively easy to demonstrate relevance of geothermal activity to various spheres of human life both in the past and now.

However, geothermal heritage is also fragile and may be hazardous (Newhall, 2014). Fragility can be seen in several contexts. The presence of soft ground and the delicate nature of silica or carbonate deposition, especially at touristic sites, mean that it is easy to damage, spoil or deface geothermal manifestations, which will be then deprived of their scenic qualities (Steingisser and Marcus, 2009). Threats become augmented ifthe property is heavily visited, up to the stage of overcrowding. Not only the likelihood of damage rises, but solutions to channelize tourist flows may be more and more intrusive in the landscape, while also increasing physical distance between visitors and phenomena to be observed. Hazards arise from the presence of high temperatures of both air, ground, and water, emanations of harmful gases, possibility of ground collapses, and chance of unexpected hydrothermal explosions. More distant threats may result from competition for resources with industry. Geothermal heat is an obvious source of energy and countries rich in these resources (Iceland, New Zealand) have a record of their successful utilization. However, negative side effects range from visual interference with the physical landscape to extinction of geysers due to overexploitation and change of groundwater conditions (Scott and Cody, 2000; Scott et al., 2005; Steingisser and Marcus, 2009).

Challenges in geoconservation at geothermal sites are closely related to the above threats. Referring to the field of (geo)tourism, the main challenge is to satisfy the needs and expectations of visitors without inducing any detrimental effects on the heritage itself, which is far more difficult in hazardous and unstable places than at classic geoheritage sites, which expose solid rocks from the past. It has long been observed that management of dynamic geoheritage requires specific approach (Smith, 2005) and strategies to cope with change have to be enforced, realizing that change can occur at slow rate (ongoing rock alteration, silica deposition) but may also happen instantaneously, even violently. In effect, certain geothermal phenomena can become extinct and disappear, including features considered hallmarks of specific areas (e.g. Geysir in Iceland, several features in New Zealand, discussed later in the paper). Thus, the principle of minimum interference at geothermal sites can be particularly difficult to implement.

In the next part of the paper it will be shown how these opportunities and challenges are addressed at selected geothermal sites in the North Island of New Zealand, developed for tourism purposes and promoted as tourist destinations.

3. Geological background of geothermal activity in New Zealand

Geothermal fields of New Zealand are associated with the Taupo Volcanic Zone (TVZ) that runs SW–NE across the central-north part of the North Island (Fig. 1) and is the surface expression of subduction of the Pacific Plate beneath the Australian Plate (Wilson and Rowland, 2016). The TVZ is located c. 250 km west from the actual plate junction at the Hikurangi Trench (Cole, 1990). Geothermal fields within the TVZ are arranged in 20 or so separate geothermal systems, spaced at quasi-regular intervals of 10–20 km (Hunt et al., 1994). Surface manifestations vary between separate systems, some being more evident and scenic than others. Typical primary components of individual geothermal fields include geysers, hot or even boiling springs and pools, fumaroles (steam vents), mud pools and mud volcanoes. Secondary effects of hot water discharge include mineral precipitation (mostly silica) around the vents and along the path of water runoff and these sinter deposits may assume the form of cones, flats, cascades ('petrified waterfalls'), terraces and raised rims around the springs. Another secondary effect is the origin of collapse craters, formed due to complete alteration and dissolution of rock underground due to contact with hot solutions. Occasionally, hydrothermal